

Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 0 887 783 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**30.12.1998 Bulletin 1998/53**

(51) Int Cl.<sup>6</sup>: **G09G 3/00**

(21) Application number: **98650038.7**

(22) Date of filing: **25.06.1998**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventor: **Malkin, Sergay**  
**Ramat Gan 52336 (IL)**

(74) Representative: **McCarthy, Denis Alexis et al**  
**MacLachlan & Donaldson**  
**47 Merrion Square**  
**Dublin 2 (IE)**

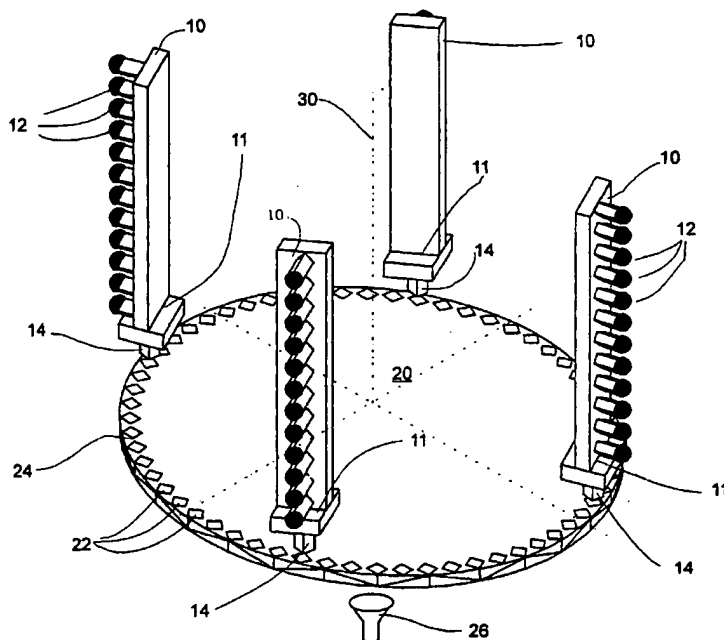
(30) Priority: **26.06.1997 US 883002**

(71) Applicant: **Light Spin Ltd.**  
**70400 Ness Ziona (IL)**

(54) **Moving display**

(57) A display of the type in which a mobile unit moves one or more arrays of light sources repeatedly through a sequence of positions in a display zone to create the illusion of a floating image. According to a first aspect of the invention, each array is provided with a mechanism for sensing when it arrives at each position in the display zone, and each array then is provided with data to display at that position. According to a second aspect of the present invention, the display is provided

with a data storage medium that is geometrically congruent with the path along which the arrays move, and the data to be displayed are read from the data storage medium as the mobile unit moves past the data storage medium. In preferred embodiments of the present invention, the path of motion of the arrays is circular; and, within the second aspect of the invention, the data storage medium is a cylindrical medium, for example, a floppy disk or a compact disk.



**Fig. 1**

**EP 0 887 783 A2**

**Description****FIELD AND BACKGROUND OF THE INVENTION**

5 The present invention relates to electrical and electronic displays and, more particularly, to a type of display in which a display zone is scanned repeatedly by one or more arrays of lights to create the illusion of an image floating in space.

Displays of this type are known. Illustrative examples include those described by Lock in UK Patent Application No. GB 2 093 617 A and by Belcher et al. in US Patent No. 5,302,965, both of which are incorporated by reference for  
10 all purposes as if fully set forth herein. Generally, these displays consist of a mobile, typically rotating, unit and a stationary unit. For example, in the displays of Lock and Belcher et al., the mobile unit in fact does only rotate with respect to the stationary unit. The mobile unit includes at least one array of light sources, typically light emitting diodes, oriented perpendicularly to the direction of motion of the mobile unit. As the mobile unit moves, the arrays of light sources sweep a path in a display zone. At each of several positions of the arrays within the display zone, different  
15 combinations of the light sources are illuminated. This creates the illusion of an image floating in space, with each light source at each position corresponding to one pixel of the image, and one column of pixels being displayed at each position. With appropriate sequencing of the illumination and extinction of the light sources, this image can be animated.

Displays of this kind suffer from two limitations. The first limitation relates to the accuracy with which the light sources can be positioned relative to the desired column positions. In known devices, the positions of the arrays are  
20 determined by measuring the position of the mobile unit as a whole, and inferring the positions of the arrays from this single measurement. For example, in one embodiment of Lock's display, the periphery of a slotted disk fixed to the stationary unit is scanned by an optical reading device fixed to the rotating unit to measure the angular position of the rotating unit relative to the stationary unit. The accuracy and stability of the inferred (nominal) positions of the arrays relative to their actual positions then depends on the accurate alignment and mechanical stability of the mobile unit.  
25 In principle, only one array need be used to scan the display zone. In practice, there is a tradeoff between number of arrays, scan speed, and illumination level; and several arrays are needed to achieve an adequate level of illumination and an adequate scan speed. Small inaccuracies in the alignment of the mobile unit, and mechanical instability of the mobile unit, cause the arrays to be in positions other than their nominal positions as the mobile unit move. Because the light sources of the arrays are turned on and off sequentially as though the arrays were in their nominal positions,  
30 the resulting image is blurred.

A second limitation of these kinds of arrays relates to the limited amount of data that can be stored on the mobile unit. Typically, the mobile unit stores only as much data as is needed to display a small number of images, with a much larger store of data being stored in the stationary unit. In the display of Belcher et al., for example, data for new images may be transmitted from the stationary unit to the mobile unit, but only at a rate much slower than the rate at which  
35 the corresponding signals must be transmitted to the moving arrays. This limits the extent to which these displays may be used to display animated images.

There is thus a widely recognized need for, and it would be highly advantageous to have, a display, of the type in which a display zone is scanned repeatedly by one or more arrays of lights to create the illusion of an image floating in space, in which control signals are transmitted to the arrays according to their actual positions, rather than their  
40 nominal positions, and at a rate fast enough to support animation of the floating image.

**SUMMARY OF THE INVENTION**

According to the present invention there is provided a display of the type in which a plurality of arrays of light  
45 sources are moved successively among a plurality of positions in a common plane of motion to perform a repetitive scanning of a display zone, including: (a) a mechanism for providing each array with data to display at each one of the positions when the array has arrived at the each one of the positions; and (b) for each array, a mechanism for detecting an arrival of the array at the each one of the positions.

According to the present invention there is provided a display for displaying an image in a display zone, including:  
50 (a) a stationary unit; (b) a mobile unit, including at least one array of light sources, for moving the at least one array of light sources successively among a plurality of positions along a path to perform a repetitive scanning of the display zone; (c) a medium for storing data to be displayed by the at least one array at each of the positions, the medium being geometrically congruent with the path; (d) a mechanism, rigidly attached to the stationary unit, for securing the medium on the stationary unit; and (e) a mechanism, rigidly attached to the mobile unit, for reading the data as the moving unit  
55 moves.

According to the present invention there is provided, in a system wherein a static image is displayed by moving at least one illuminator successively among a plurality of positions, data to be displayed at each of the positions being provided to each of the at least one illuminator at a certain static refresh frequency, a method for displaying an image

moving at a constant speed, including the steps of: (a) determining a moving refresh frequency, based on the static refresh frequency and on the constant speed; and (b) providing the data to each of the at least one illuminator at the moving refresh frequency.

According to a first aspect of the present invention, related to a display in which the arrays move among a set of coplanar positions, each array is provided with a mechanism for sensing when it arrives at one of the positions, and the stationary unit is configured to transmit to each array, when it arrives at a certain position, only the data that is to be displayed by the array at that position. In the examples of preferred embodiments described herein, the positions are along the circumference of a circle, although the scope of the present invention includes displays in which the arrays move in any coplanar sequence of array positions. In one embodiment of this aspect of the present invention, the stationary unit is provided with a flat surface bearing a circular pattern of apertures, each aperture corresponding to one sequential position of the arrays, and is also provided with an illumination source on the opposite side of this surface from the mobile unit; and each array is provided with an optical sensor to sense when it transits from one aperture to the next, based on the periodic alternation of the presence and absence of light transmitted through the flat surface. A control system in the stationary unit continuously interrogates the arrays and, upon determining that a given array has arrived at a certain position, transmits to that array the data to be displayed at that position. In another embodiment of this aspect of the present invention, the stationary unit is provided with a circular ensemble of conductive plates, each plate corresponding to one sequential position of the arrays, and is also provided with electrical connections from a memory device to the conductive plates, whereby each conductive plate is provided with electrical signals corresponding to the data to be displayed at the corresponding position. Each array is provided with a pair of parallel conductive plates, disposed so that as that array sweeps past a particular position, the conductive plate of the circular ensemble that corresponds to that position is sandwiched between the parallel plates attached to the array, forming a capacitively coupled link between the memory device and the array, so that the data to be displayed at that position is transmitted to the array.

According to a second aspect of the present invention, in which the arrays move repetitively along a certain path as the mobile unit moves with respect to the stationary unit, the stationary unit includes a mechanism for holding a data storage medium, such as a magnetic storage medium, that is geometrically congruent with the path followed by the arrays, and the mobile unit includes a mechanism, such as a magnetic read head, for reading the data stored on the data storage medium as the mobile unit moves past the data storage medium. The scope of the present invention includes all such paths, with geometric congruence being established by the use of flexible magnetic tape, shaped to follow the path, as the data storage medium. For example, if the mobile unit moves the arrays back and forth along a linear path, the magnetic tape is stretched out parallel to the path. Nevertheless, in the preferred embodiment of this aspect of the present invention, the path is circular, the mobile unit rotates on an axis relative to the stationary unit, and the data storage medium is cylindrical, for example, a floppy disk, and is secured on the stationary unit concentric with the axis of rotation. With an appropriate ordering of the data on a cylindrical storage medium, as described below, data to be displayed by each array at each position may be transferred to that array in real time, allowing the arrays to have direct access to the full data set to be displayed.

It will be appreciated that, within the preferred embodiment of the second aspect of the present invention, the cylindrical data storage medium need not be magnetic. For example, the data storage medium may be a compact disk, read by an optical read head in the mobile unit.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a partial perspective view of a first embodiment of the present invention;  
 FIG. 2 is a schematic block diagram of the electronic circuitry of the embodiment of FIG. 1;  
 FIG. 3 is a partial perspective view of a second embodiment of the present invention;  
 FIG. 4 is a schematic block diagram of the electronic circuitry of the embodiment of FIG. 3;  
 FIG. 5 is a vertical cross section of a third embodiment of the present invention;  
 FIG. 6 is a vertical cross section of a fourth embodiment of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of a display, of the type that creates the illusion of an image floating in space, in which the arrays that create the illusion are provided with display data in a manner that eliminates the blurring of the image and that enables full animation of the image.

The principles and operation of a display according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, Figure 1 is a partial perspective view of a first preferred embodiment of the present invention. In this embodiment, the stationary unit includes an opaque barrier 20 coextensive with one surface thereof, and the mobile unit, which rotates at a uniform angular velocity about an axis 30 relative to the stationary unit, includes four linear arrays 10 of light emitting diodes (LEDs) 12. As the mobile unit rotates, ends 11 of arrays 12 move in a circular path that is slightly displaced from and parallel to barrier 20. The stationary unit also includes an illumination source 26 on the side of barrier 20 opposite the mobile unit. Barrier 20 includes a plurality of evenly spaced apertures 22 arrayed in a circle that is directly opposite to the circular path of motion of ends 11 of arrays 12, at positions corresponding to the pixel columns of the floating images displayed by means of LEDs 12. Between one pair of evenly spaced apertures 22 is an initial position aperture 24. Each array 12 includes an optical sensor 14 on end 11 thereof. Optical sensors 14 are used to detect light from source 26 that traverses barrier 20 via apertures 22 and 24 to indicate to each array 12 the arrival of array 12 at a position opposite each of apertures 22 and 24.

Note that only the parts of this embodiment that are relevant to a description of the present invention are shown in Figure 1. So, for example, the mechanism for rotating the mobile unit at a uniform angular velocity about axis 30 relative to the stationary unit is not shown. The mechanisms taught by Lock and by Belcher et al. are readily adapted to this purpose by one ordinarily skilled in the art. If the mechanism taught by Lock is used, then opaque barrier 20 forms the upper surface of the stationary unit.

It will be appreciated that the principle upon which the embodiment of Figure 1 is based is the discrete illumination, along a surface of the stationary unit, of positions along the path followed by arrays 12 that correspond to the pixel columns of the images to be displayed. So, for example, instead of source 26 and apertures 22 and 24, the stationary unit may include a circular ensemble of LEDs in the surface thereof past which ends 11 of arrays 12 move.

Figure 2 is a schematic block diagram of the electronic circuitry that drives arrays 10, under the control of a microprocessor-based control unit 60. Data corresponding to the images to be displayed is stored in a memory unit 62. Control unit 60 addresses this data via an address bus 64. The addressed is provided to control unit 60 via a data bus 66. Control unit 60 and memory 62 are located in the stationary unit.

The mobile unit includes, for each array 10, a corresponding control module 40. Control module 40 includes a pulse selector 42, a counter 44, a flip flop 46, a shift register 48 and a register driver 50. Communication links between control modules 40 and control unit 60, symbolized in Figure 2 by the vertical lines and the vertical double arrow that connect control unit 60 and control module 40, are provided as taught by Lock and by Belcher et al. For clarity, only one control module 40 is shown in Figure 2.

Whenever sensor 14 arrives opposite aperture 22 or 24, light traversing barrier 20 via aperture 22 or 24 causes an electrical pulse to be sent to counter 44. Pulse selector 42 distinguishes a pulse due to an arrival of sensor 14 opposite aperture 24 from pulses due to arrivals of sensor 14 opposite apertures 22, on the basis of the time interval between a pulse due to an arrival of sensor 14 opposite aperture 24 and the immediately preceding pulse being half of the time interval between arrivals of sensor 14 opposite adjacent apertures 22. Upon detecting a pulse due to an arrival of sensor 14 opposite aperture 24, pulse selector 42 resets counter 44 to the initial state thereof. Upon detecting a pulse due to an arrival of sensor 14 opposite one of apertures 22, pulse selector 42 increases the count stored in counter 44 by one unit. Thus, the angular position of array 10 relative to the stationary unit is indicated by the state of counter 44. Each electrical pulse from sensor 14 also sets flip flop 46 to the active state thereof and causes data transfer from shift register 48 to register driver 50 which drives LEDs 12 of array 10.

Periodically, at a rate higher (typically twice as high) than the time interval between arrivals of sensors 14 at adjacent apertures 22, control unit 60 interrogates flip flop 46. If flip flop 46 is in its active state, control unit 60 reads the state of counter 44 to determine the angular position of array 10. Control unit 60 then reads data corresponding to that angular position from memory 62, transfers these data to shift register 48, and resets flip flop 46.

Figure 3 is a partial perspective view of a second embodiment of the present invention. In this embodiment, the surface of the stationary unit, past which the mobile unit rotates about axis 30, is provided with a circular ensemble of conductive plates 70. Each plate 70 is located at a point corresponding to a pixel column of the images to be displayed. Each array 10 is provided, at end 11 thereof, with a pair of conductive plates 72 that straddle conductive plates 70, providing, at each conductive plate 70 so straddled, a capacitive link between array 10 and the stationary unit. Each conductive plate 70 is connected by a wire 76 to control unit 60, whereby control unit 60 transmits to each conductive plate 70 only data to be displayed in the corresponding column of image pixels.

Figure 4 is a schematic block diagram of the electronic circuitry that drives arrays 10 in the embodiment of Figure 3, again under the control of control unit 60 in the stationary unit. There are an even number of conductive plates 70, each conductive plate 70 being connected to control unit 60 by wires 76. Alternate conductive plates 70 are connected to control unit 60 via inverters 78. For clarity, only 7 conductive plates 70 are shown in Figure 4.

The mobile unit includes, for each array 10, a corresponding control module 80, for receiving signals through the capacitively coupled links between conductive plates 70 and 72. Control module 80 includes a demodulator 82, a data packet detector 84, a shift register 86, a phase lock loop 90, a pulse shaper 98 and a register driver 100. Phase lock loop 90 in turn includes a phase detector 92, a low pass filter 94 and a voltage controlled oscillator 96. For clarity, only

one mobile unit **80** is shown in Figure 4.

Control unit **60** transmits data to conductive plates **70** as a modulated carrier wave. Every other conductive plate **70** receives this modulated carrier wave, via inverter **78**, as an inverted wave. The modulated carrier wave is transmitted, via the capacitively coupled link between conductive plates **70** and **72**, to demodulator **82** and phase lock loop **90**. Phase lock loop **90** supplies demodulator **82** with a signal identical to the carrier wave, except for being 90° out of phase with the carrier wave: the reference signal leads uninverted modulated signals (signals that do not traverse one of inverters **78**) by 90° and lags inverted modulated signals (signals that do traverse one of inverters **78**) by 90°. Demodulator **82** uses the reference signal from phase lock loop **90** to recover the data from the modulated signals and pass the data on to data packet detector **84**.

Data are transmitted in packets, with each packet including a preamble, a postamble, and, between the preamble and the postamble, bits corresponding to the sequence of LEDs **12** to be turned on and off at the angular position of each conductive plate **70**. Several (preferably at least three) packets are transmitted in the time that it takes for an array **10** to sweep past one conductive plate **70**, so that the transmission of data to arrays **10** need not be exactly synchronized with the angular positions of arrays **10**. When data packet detector **84** detects the arrival of a complete packet, including the preamble and the postamble, data packet detector **84** strips the preamble and the postamble from the packet and passes on the data to shift register **86**, along with a synchronization signal.

The output of low pass filter **94**, in addition to being passed to voltage controlled oscillator **96**, is passed to pulse shaper **98**. Whenever a capacitively coupled link is broken with one conductive plate **70** and established with the next conductive plate **70**, the polarity of the output of low pass filter **94** changes. Pulse shaper **98** transforms this polarity change to a pulse, which triggers register driver **100** to write the data stored in shift register **86** to array **10**.

The capacitive communications link described herein for transmitting data from control unit **60** to arrays **10**, including wires **76** and conductive plates **70** and **72**, is one illustrative example of a multichannel communications link between control unit **60** and arrays **10**. The scope of the present invention includes all equivalent links, for example, optical links and magnetic induction links.

In both the first embodiment and the second embodiment, typical rotational speeds range from 100 rpm to 900 rpm, and the number of pixel columns in the image typically range between 64 and 512. Thus, in the first embodiment, typically there are between 64 and 512 apertures **22** in opaque barrier **20**, and in the second embodiment, typically there are between 64 and 512 conductive plates **70**.

Figure 5 is a vertical cross section through a third embodiment of the present invention, illustrating the second aspect of the present invention. In this embodiment, a mobile unit **100** includes two linear arrays **110** of LEDs **112** at the ends of oppositely directed arms **114** that extend from a central hollow cylindrical shaft **116**. Mounted above shaft **116** is a control unit **118**. To the end of shaft **116** opposite arms **114** is rigidly attached a floppy disk drive **120** that includes a magnetic read head **122**, a radial positioning drive **124**, and other standard components not shown in Figure 5. An electrical connection (not shown) is provided between control unit **118** and disk drive **120** through the hollow interior of shaft **116**. This embodiment also includes a stationary unit **105**, which includes a sleeve **132**, that is mounted on a base **130**, and that contains bearings **134** within which shaft **116** is rotatably mounted. Stationary unit **105** also includes a motor **136**, mounted on base **130**, that drives the rotation of shaft **116** by means of a drive belt **138** and a pulley **140**.

A floppy disk **150**, within a floppy disk case **152**, is mounted within disk drive **120** and held stationary therein by a pressure unit **142** mounted on spindle **144** that is attached to base **130** concentric with shaft **116**. As the mobile unit, including disk drive **120**, rotates, pressure unit **142** holds floppy disk **150** stationary. Thus, the reading of floppy disk **150** is accomplished in a manner opposite to the conventional manner. Instead of floppy disk **150** rotating within case **152** and disk drive **120**, floppy disk **150** remains stationary, while disk drive **120** and case **152** rotate around floppy disk **150**.

Figure 6 is a vertical cross section through a fourth embodiment of the present invention, also illustrating the second aspect of the present invention. The embodiments of Figures 5 and 6 share most of their components, and components so shared are designated by identical reference numerals in Figures 5 and 6. In the embodiment of Figure 6, mobile unit **100** includes a central hollow cylindrical sleeve **160** atop which are mounted both disk drive **120** and control unit **118**. Stationary unit **105** includes a solid central shaft **170** about which sleeve **160** is rotatably mounted on bearings **172**. Motor **136** drives the rotation of sleeve **160** by means of drive belt **138** and a pulley **162**. Pressure unit **142** that holds floppy disk **150** in place is mounted on top of shaft **170**. Otherwise, the embodiment of Figure 6 is structurally and functionally identical to the embodiment of Figure 5.

To maximize the speed at which data are read from floppy disk **150**, the data to be displayed in successive pixel columns are interleaved. For example, if  $L$  linear arrays are used to display  $N$  pixel columns, with  $N$  being an integral multiple of  $L$ , the order of data storage is:

column 1	column $N/L + 1$	column $2N/L + 1$	...	column $N - N/L + 1$
----------	------------------	-------------------	-----	----------------------

(continued)

column 2	column $N/L + 2$	column $2N/L + 2$ ...	column $N - N/L + 2$
...			
column $N/L$	column $2N/L$	column $3N/L$ ...	column $N$

For example, in an embodiment, such as those of Figures 5 and 6, that has 2 linear arrays 110 of LEDs 112, if the image to be displayed has 64 columns, then the columns are stored in the order 1, 33, 2, 34, 3, 35, ... , 31, 63, 32, 64. The first two columns read from floppy disk 150 then are columns 1 and 33, which are in fact the first two columns to be displayed, because when one linear array 110 is at a position corresponding to pixel column 1, the other linear array 110 is diametrically opposite the first linear array 110, at a position corresponding to pixel column 33. It will be readily apparent, to one ordinarily skilled in the art, how to synchronize the reading of floppy disk 150 with the display of data on linear arrays 110 at the various positions thereof.

As noted above, the cylindrical data storage medium of the preferred embodiment of the second aspect of the present invention may be an optical storage medium such as a compact disk. Figures 5 and 6 also may be understood to represent this variant of the present invention, with reference numeral 150 designating a compact disk, reference numeral 120 designating a compact disk drive, and reference numeral 122 designating an optical read head.

The embodiments of the present invention described herein are well-suited to creating the illusion of an image floating in a single position in space. These embodiments also are well-suited to creating the illusion of an image moving at a constant velocity in space, provided appropriate care is taken to avoid spatial aliasing. This will now be explained in terms of specific examples.

The reference example is the display of a static image using the first preferred embodiment of the present invention, with 180 apertures 22. The static image has 180 columns, one per aperture 22, with each column occupying  $2^\circ$  of arc length. The mobile unit rotates at 10 revolutions per second, so that the static image is scanned by LED arrays 10 40 times per second. Each array 10 occupies the  $2^\circ$  arc length of each column for  $1/1800$  seconds. Therefore, the refresh rate at which new display data are provided to each array 10 is 1800 Hz.

Now suppose that it is desired to make the floating image rotate in the same direction as the mobile unit, only more slowly. Specifically, suppose that it is desired that the floating image rotate once every 4.5 seconds, i.e., at a constant angular speed of  $80^\circ$  per second. The naive way to implement this would be to simply translate  $80^\circ$  per second into 40 columns per second. For the first  $1/40$  second, data are transferred to register drivers 50 of arrays 10 as in the static case. For the second  $1/40$  second, data are transferred to register drivers 50 of arrays 10 in a manner corresponding to a  $2^\circ$  shift of the image: data that were formerly transferred to arrays 10 when they are opposite aperture 22 whose angular coordinate is  $0^\circ$  now are transferred to arrays 10 when they are opposite aperture 22 whose angular coordinate is  $2^\circ$ , and so on.

The problem with this naive implementation is that it leads to spatial aliasing. Consider, for example, an array 10 starting at angular position  $0^\circ$  and displaying, for the first  $1/1800$  seconds, data of image column number 1. For the second  $1/1800$  seconds, this array 10 is at angular position  $2^\circ$  and displays data of image column number 2. For the 45th  $1/1800$  seconds, this array 10 is at angular position  $88^\circ$  and displays data of image column number 45. But now,  $1/40$  of a second having elapsed, the data transfer is shifted  $2^\circ$  in the direction of rotation. As a result, for the 46th  $1/1800$  seconds, this array 10, being at angular position  $90^\circ$ , again displays data of image column number 45. In practice, this spatial aliasing produces a number of visible seams in the rotating image, the number of seams being equal to the number of arrays 10. The same effect is observed if the floating image rotates in the direction opposite to the direction in which the mobile unit rotates, the effect in this case being caused by arrays 10 skipping image columns rather than duplicating image columns.

The fundamental cause of this spatial aliasing is that, although the image columns are  $2^\circ$  wide in the rotating coordinate system of the image, they are not  $2^\circ$  wide in the stationary coordinate system of apertures 22. The way to overcome this spatial aliasing is to break the connection between the angular positions marked by apertures 22 and the angular widths of the displayed image columns.

Suppose that an array 10 starts, along with the trailing edge of an image column, at angular position  $0^\circ$  at time 0. For how long should the data of this image column be displayed? Denote this unknown time by  $t$ . Array 10 moves at  $3600^\circ$  per second. The leading edge of the image column starts at an angular position of  $2^\circ$  and moves at  $80^\circ$  per second. The data of the image column should be displayed just long enough for array 10 to catch up to the leading edge of the image column. At that point, the angular position of array 10 is  $3600t$  and the angular position of the leading edge of the image column is  $2 + 80t$ . Solving the equation  $3600t = 2 + 80t$  for  $t$  gives  $t = 1/1760$  seconds. The straightforward way to eliminate aliasing is to provide data to arrays 10 at a slower refresh rate of 1760 Hz instead of the base refresh rate of 1800 Hz. Note that under this method, the signals from sensors 14 are used, not to determine the angular positions of arrays 10, but to provide a real-time measure of the base refresh frequency, which may vary about the

nominal 1800 Hz value, depending on the accuracy with which the mobile unit is aligned and on the mechanical stability of the mobile unit. Frequency synthesis methods for synthesizing the desired refresh frequency from the base refresh frequency, based on the desired rotational speed of the image, are well-known in the art and need not be detailed here.

It will be appreciated that this method for overcoming spatial aliasing is applicable to any system in which one or more illuminators, such as LED arrays 10, are moved successively among a series of predetermined positions to display a floating and moving image.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

## Claims

1. A display of the type in which a plurality of arrays of light sources are moved successively among a plurality of positions in a common plane of motion to perform a repetitive scanning of a display zone, comprising:
  - (a) a mechanism for providing each array with data to display at each one of the positions when the array has arrived at said each one of the positions; and
  - (b) for each array, a mechanism for detecting an arrival of the array at said each one of the positions.
2. The display of claim 1, wherein said mechanism for detecting said arrival of the array at said each one of the positions includes a multi-state device, each of the positions corresponding to a different state of said multi-state device.
3. The display of claim 2, wherein said multi-state device includes a counter.
4. The display of claim 1, wherein said mechanism for detecting said arrival of the array at said each one of the positions includes a two-state device.
5. The display of claim 1, wherein said two-state device includes a flip flop.
6. The display of claim 1, further comprising:
  - (c) a plurality of coplanar indicators, each of said indicators corresponding to one of the positions;and wherein said mechanism for detecting said arrival of the array at said each one of the positions includes a sensor responsive to said indicators.
7. The display of claim 6, wherein said sensor is an optical sensor.
8. The display of claim 7, further comprising:
  - (d) a source of illumination; and
  - (e) an opaque barrier, substantially coplanar with the positions, between said source of illumination and the arrays;and wherein each of said coplanar indicators includes an aperture, transmissive of said illumination, in said opaque barrier.
9. The display of claim 1, wherein said mechanism for providing each array with data to display at each one of the positions includes a multichannel communications link.
10. The display of claim 9, wherein said multichannel communications link transmits said data as a modulated carrier wave signal, wherein, for any pair of positions occupied successively by any one of the arrays, said signal corresponding to a second position of said pair of positions is inverted with respect to said signal corresponding to a first position of said pair of positions.
11. The display of claim 10, wherein said mechanism for detecting said arrival of the array at said each one of the positions includes a mechanism for recognizing said inverted signals.

12. The display of claim 11, wherein said mechanism for recognizing said inverted signals includes a phase lock loop.

13. The display of claim 9, wherein said multichannel communications link includes:

- 5 (i) a plurality of coplanar conductive plates, each of said coplanar plates corresponding to one of the positions;  
and  
(ii) on each of the arrays, at least one conductive plate, disposed so that when the array is at any one of the  
positions, said coplanar conductive plate corresponding to said one position is adjacent to said conductive  
plate of the array, thereby establishing a capacitive communications link.

10 14. A display for displaying an image in a display zone, comprising:

- (a) a stationary unit;  
15 (b) a mobile unit, including at least one array of light sources, for moving said at least one array of light sources  
successively among a plurality of positions along a path to perform a repetitive scanning of the display zone;  
(c) a medium for storing data to be displayed by the at least one array at each of the positions, said medium  
being geometrically congruent with the path;  
(d) a mechanism, rigidly attached to the stationary unit, for securing said medium on the stationary unit; and  
20 (e) a mechanism, rigidly attached to the mobile unit, for reading said data as the moving unit moves.

15 15. The display of claim 14, wherein said medium is a magnetic storage medium, and wherein said mechanism for  
reading said data includes a magnetic read head.

25 16. The display of claim 14, wherein said mobile unit rotates about an axis with respect to said stationary unit, so that  
said path is a circle; and wherein said medium is cylindrical.

17. The display of claim 16, wherein said medium includes a disk storage device.

30 18. The display of claim 17, wherein said disk storage device is a floppy disk.

19. The display of claim 14, wherein said medium is an optical storage medium, and wherein said mechanism for  
reading said data includes an optical read head.

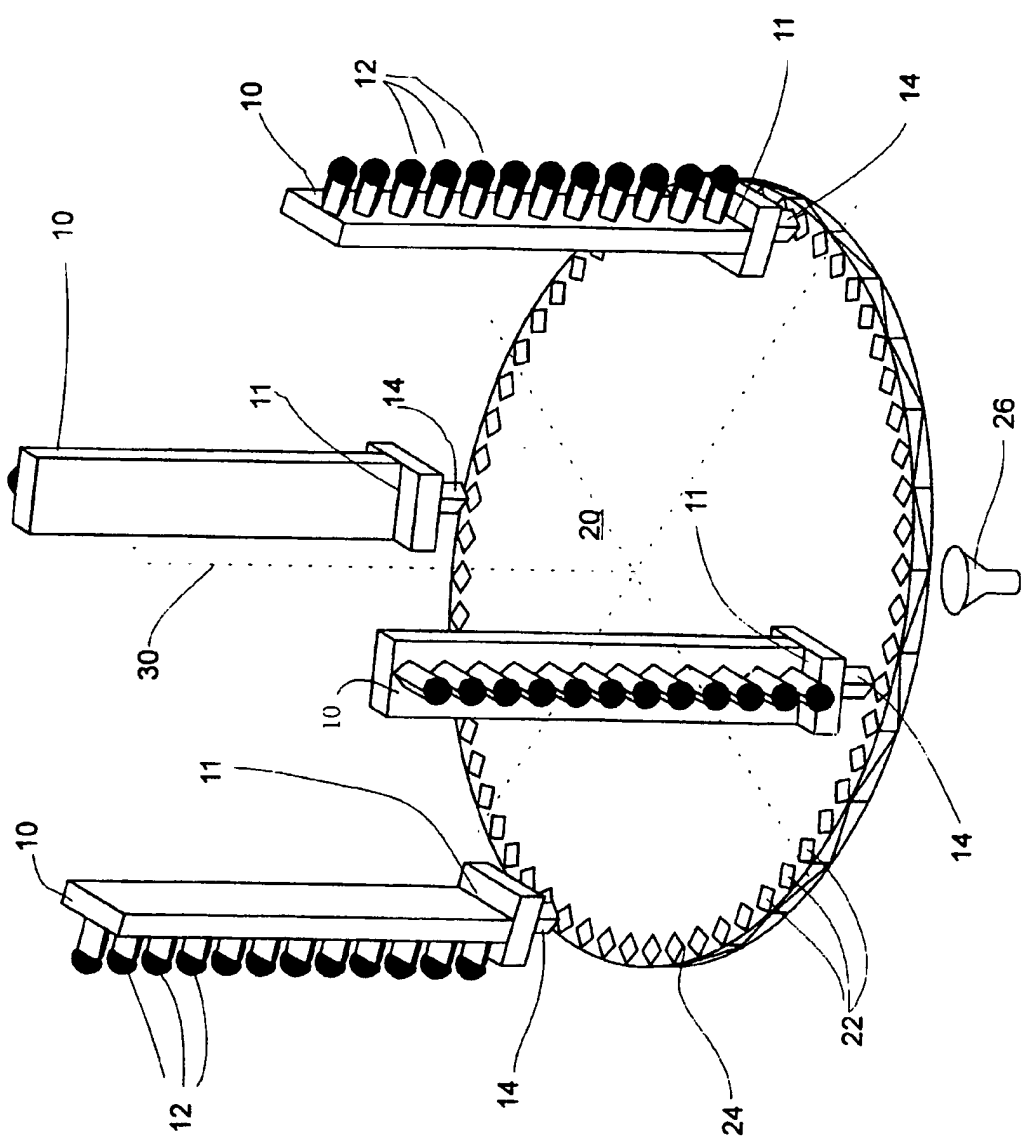
35 20. The display of claim 19, wherein said medium includes a compact disk.

40 21. In a system wherein a static image is displayed by moving at least one illuminator successively among a plurality  
of positions, data to be displayed at each of the positions being provided to each of the at least one illuminator at  
a certain static refresh frequency, a method for displaying an image moving at a constant speed, comprising the  
steps of:

- (a) determining a moving refresh frequency, based on the static refresh frequency and on the constant speed;  
and  
(b) providing the data to each of the at least one illuminator at said moving refresh frequency.



Fig. 1



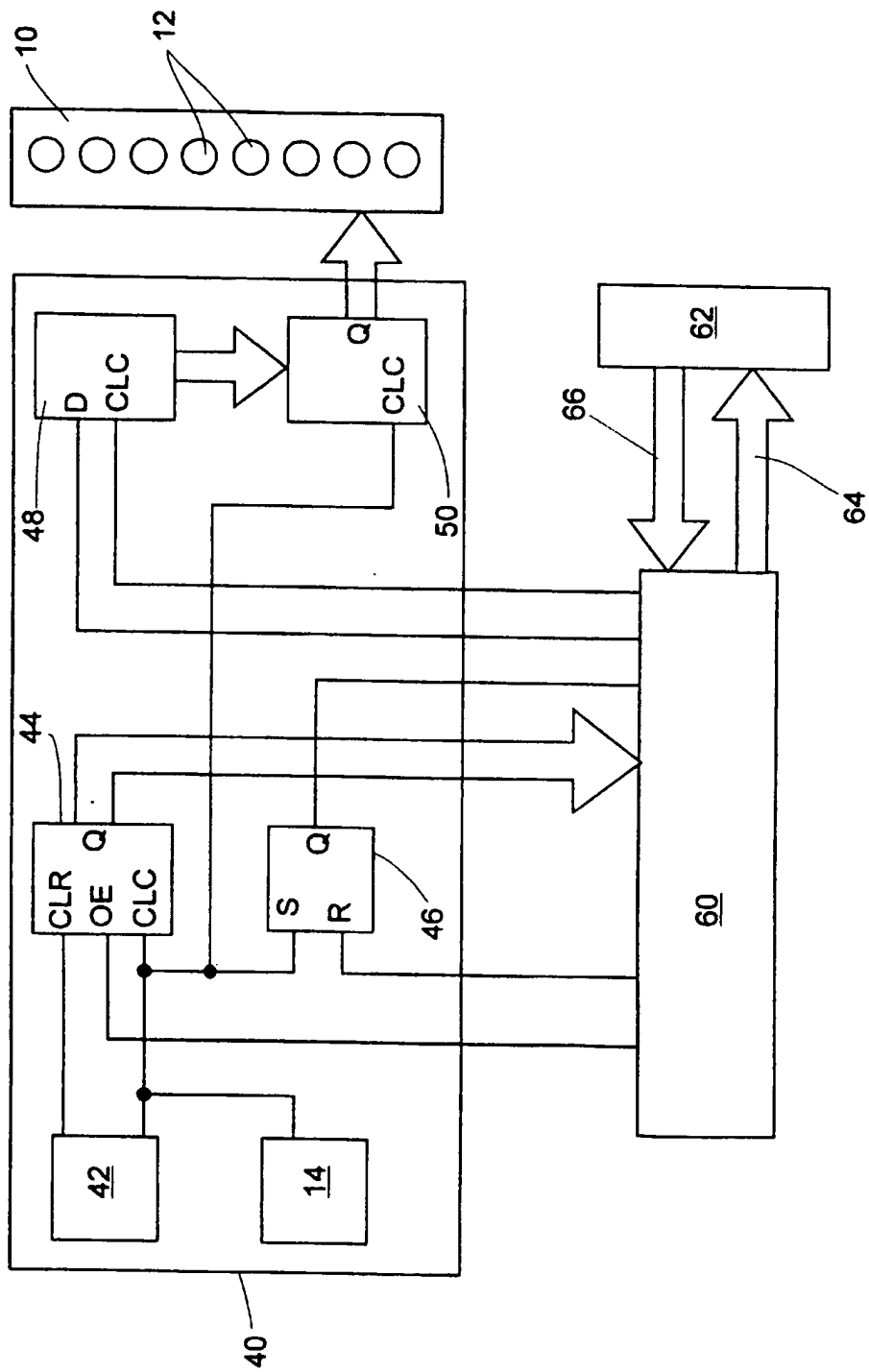
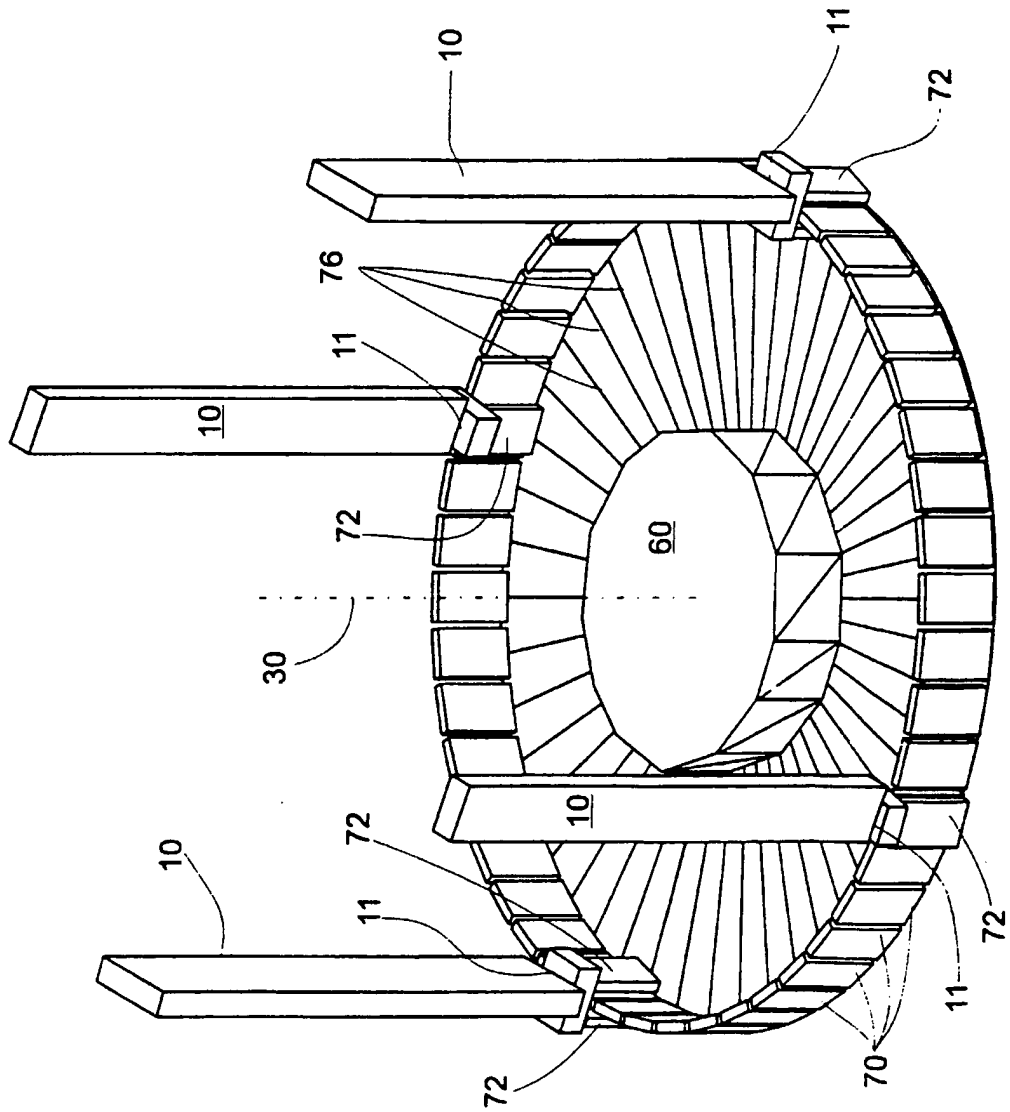


Fig. 2



**Fig. 3**

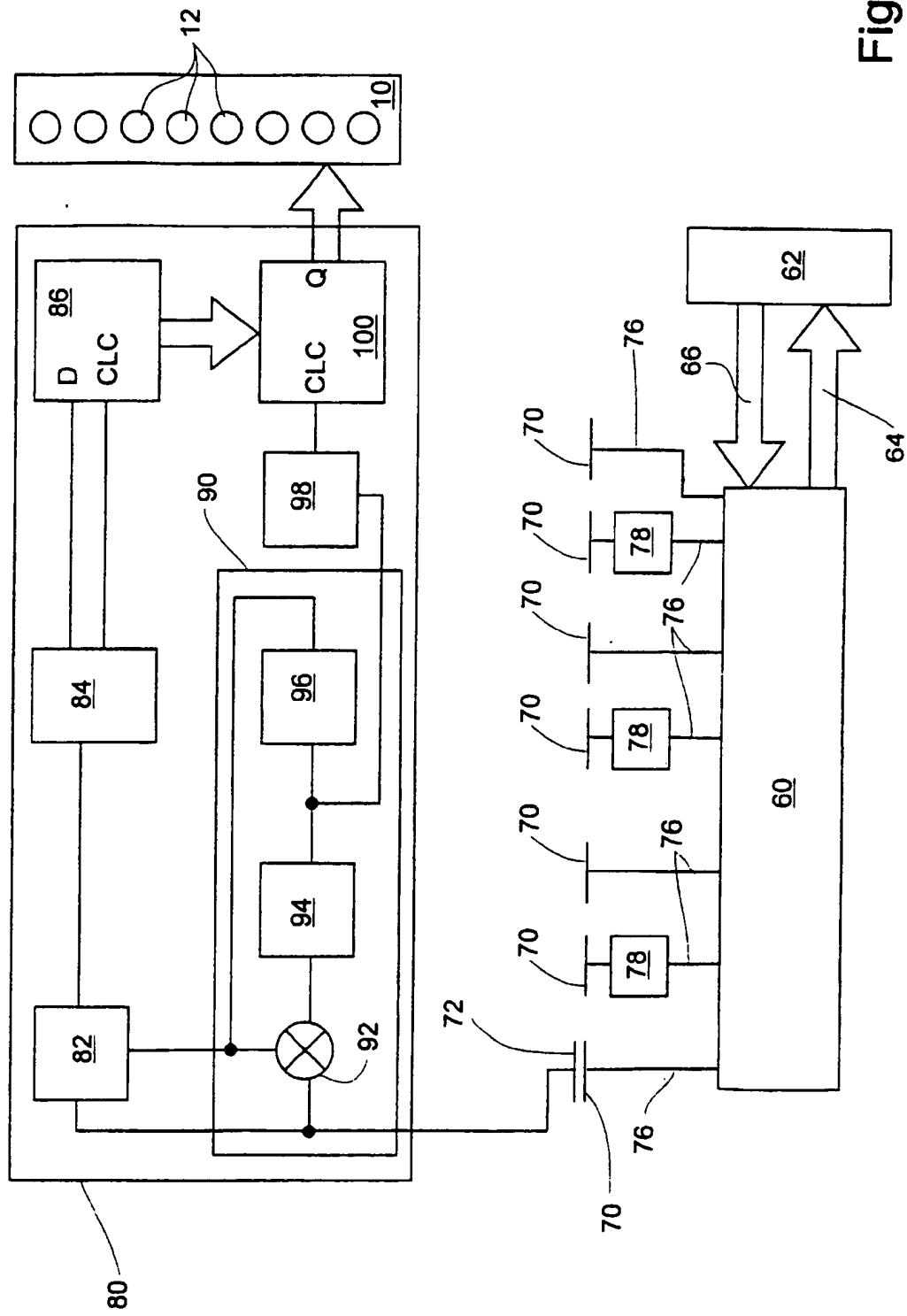


Fig. 4

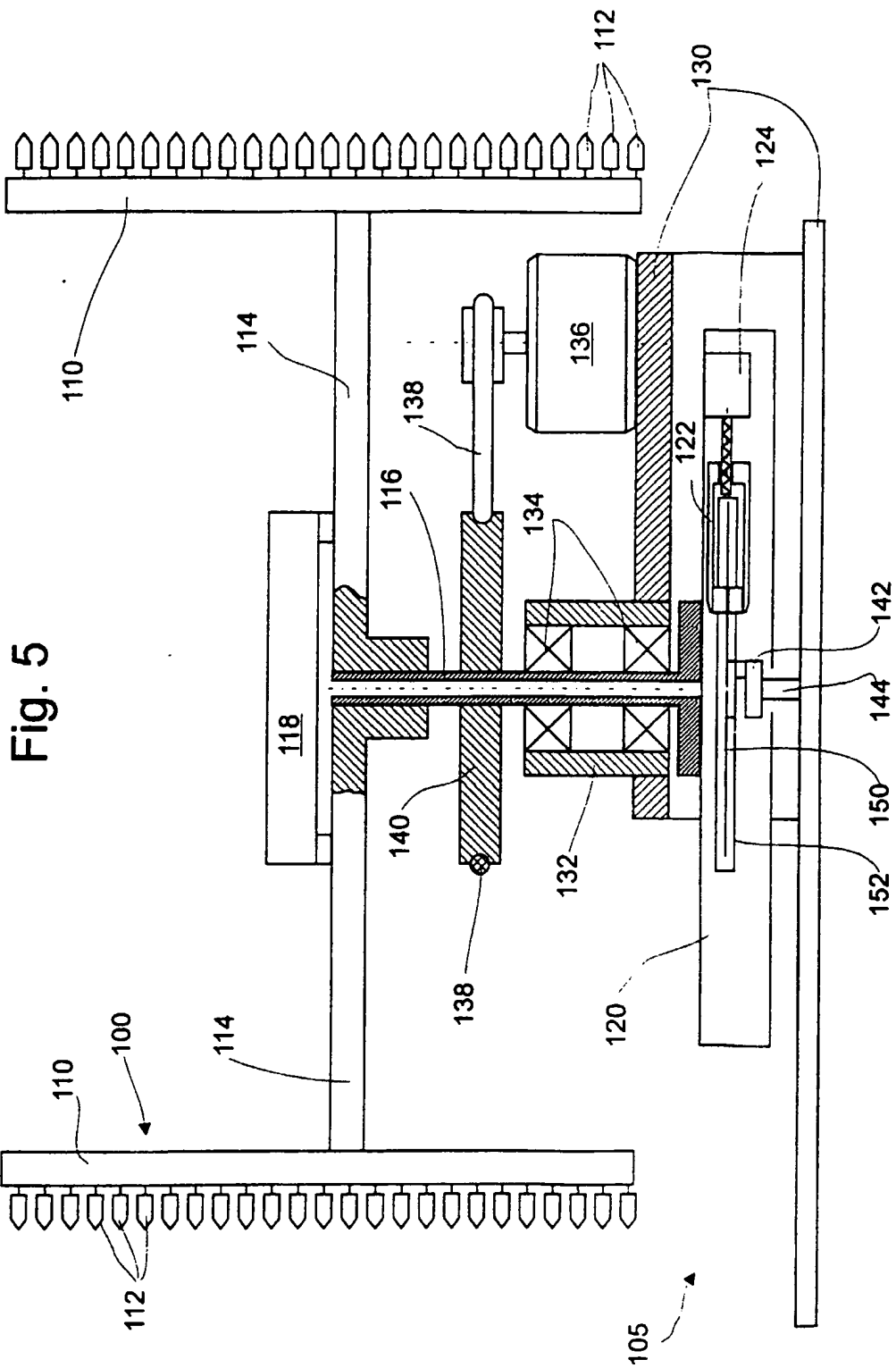
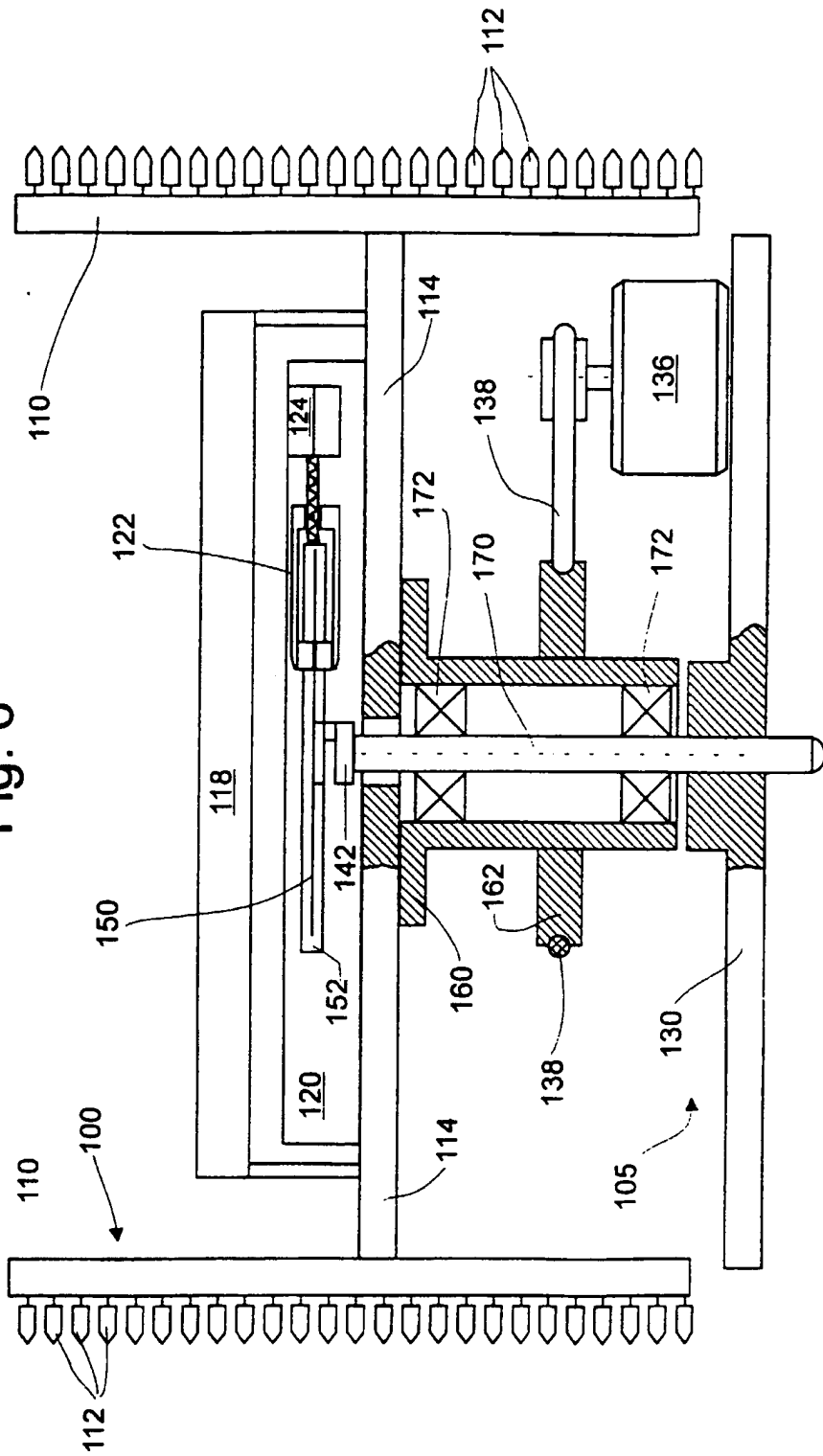


Fig. 6





(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:  
**02.06.1999 Bulletin 1999/22**

(51) Int Cl.<sup>6</sup>: **G09G 3/00**

(43) Date of publication A2:  
**30.12.1998 Bulletin 1998/53**

(21) Application number: **98650038.7**

(22) Date of filing: **25.06.1998**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE**  
 Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventor: **Malkin, Sergay**  
**Ramat Gan 52336 (IL)**

(74) Representative: **McCarthy, Denis Alexis et al**  
**MacLachlan & Donaldson**  
**47 Merrion Square**  
**Dublin 2 (IE)**

(30) Priority: **26.06.1997 US 883002**

(71) Applicant: **Light Spin Ltd.**  
**70400 Ness Ziona (IL)**

(54) **Moving display**

(57) A display of the type in which a mobile unit moves one or more arrays of light sources repeatedly through a sequence of positions in a display zone to create the illusion of a floating image. According to a first aspect of the invention, each array is provided with a mechanism for sensing when it arrives at each position in the display zone, and each array then is provided with data to display at that position. According to a second aspect of the present invention, the display is provided

with a data storage medium that is geometrically congruent with the path along which the arrays move, and the data to be displayed are read from the data storage medium as the mobile unit moves past the data storage medium. In preferred embodiments of the present invention, the path of motion of the arrays is circular; and, within the second aspect of the invention, the data storage medium is a cylindrical medium, for example, a floppy disk or a compact disk.

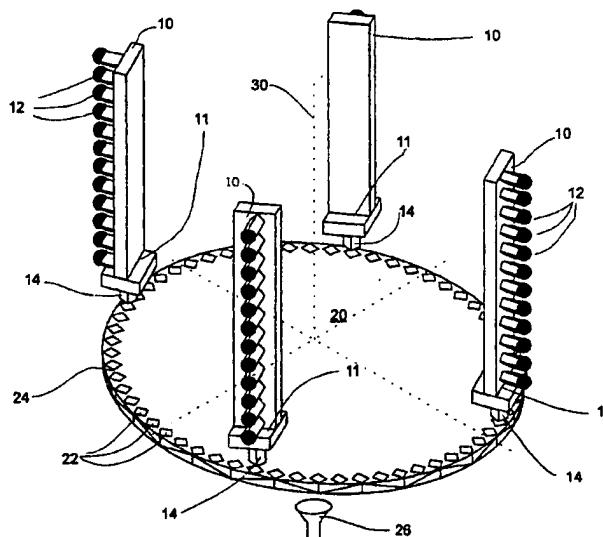


Fig. 1



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 98 65 0038

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.8)
X	GB 2 280 059 A (SCITEX CORP LTD) 18 January 1995	1,9	G09G3/00
A	* page 5, paragraph 1 - page 16, paragraph 3; figures 1-3,5,6 *	2-7	
D,A	GB 2 093 617 A (LOCK TREVOR JOHN;SCOTT HUBBARD JOHN EDWARD) 2 September 1982 * page 1, line 95 - page 3, line 22; figures 2,3 *	1-7,21	
A	US 5 057 827 A (NOBILE FRED E ET AL) 15 October 1991 * column 3, line 10 - column 4, line 30 * * column 5, line 18 - column 6, line 4 * * figures 1,2,8 *	1-7,9	
A	WO 83 02352 A (DASH STRAUS ASSOCIATES) 7 July 1983 * abstract; figure 1 *	13	
A	GB 2 095 068 A (COLLENDER ROBERT R) 22 September 1982 * page 6, line 11 - page 7, line 22; figure 11 *	14-17	TECHNICAL FIELDS SEARCHED (Int.Cl.8)  G09G H04N H04B G09F
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>14 April 1999</b>	Examiner <b>Amian, D</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPF FORM 1503 03/82 (mod.001)



**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 65 0038

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-04-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2280059 A	18-01-1995	DE 4424887 A	19-01-1995
GB 2093617 A	02-09-1982	NONE	
US 5057827 A	15-10-1991	NONE	
WO 8302352 A	07-07-1983	CA 1208821 A	29-07-1986
		EP 0097714 A	11-01-1984
		US 4573048 A	25-02-1986
GB 2095068 A	22-09-1982	AU 540347 B	15-11-1984
		AU 6828581 A	16-09-1982
		BE 888172 A	30-09-1981
		CA 1146260 A	10-05-1983
		CH 644726 A	15-08-1984
		DE 3112547 A	28-10-1982
		FR 2502881 A	01-10-1982
		JP 1679800 C	13-07-1992
		JP 3043832 B	03-07-1991
		JP 57162898 A	06-10-1982
		NL 8101553 A	18-10-1982

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82